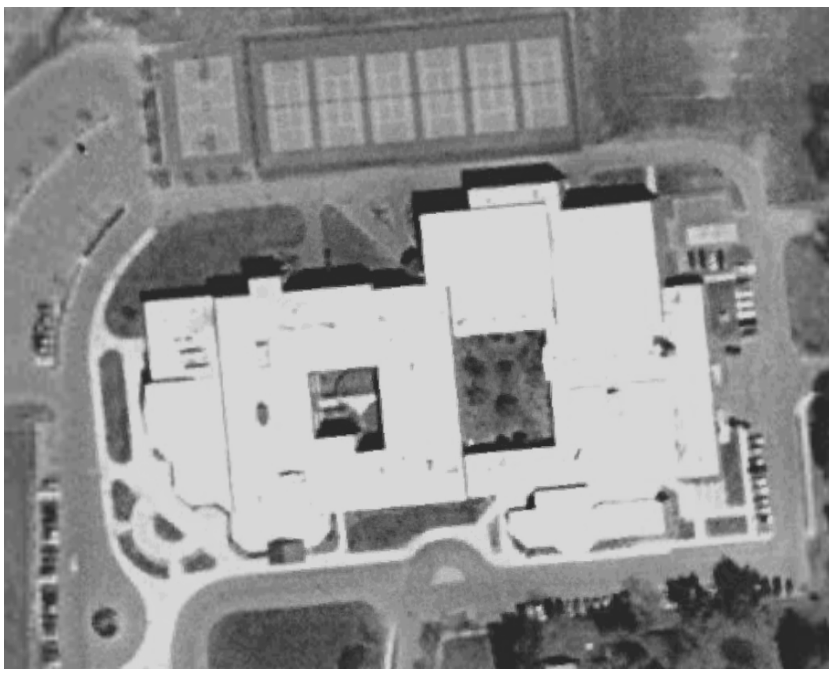
INDOOR AIR QUALITY ASSESSMENT

John F. Kennedy Middle School
100 Bridge Road
Village of Florence
Northampton, MA 01062



Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program

March 2006

Background/Introduction

At the request of the Northampton Health Department, the Massachusetts Department of Public Health's (MDPH) Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality at the John F. Kennedy Middle School (JFKMS) located at 100 Bridge Road in Florence, a village within the city of Northampton, Massachusetts. The request was prompted by symptoms (e.g., headaches; exacerbation of allergies; dryness; eye and respiratory irritation; lethargy) that occupants believed to be associated with poor indoor air quality.

On January 6, 2006, Sharon Lee, an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program, conducted an assessment at the JFKMS. During the assessment, Ms. Lee was accompanied by Greg Rochan, Maintenance Foreman, Northampton Public Schools (NPS), and Amy LeBeau, Maintenance/Custodian, JFKMS.

The JFKMS is a red brick and metal building completed circa 1993. The school contains general classrooms, science labs, special education rooms, computer room, library, nurse's office, cafeteria, kitchen, teachers' rooms, art room, music room, gymnasium, pool and office space. Windows throughout the building are openable.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particulate matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). CEH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

This school houses approximately 700 students in grades 6 through 8, with approximately 90 staff members. Tests were taken during normal operations at the school. Results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were elevated above 800 parts per million (ppm) in 61 of 66 areas, indicating poor ventilation in the majority of areas surveyed. Fresh air in classrooms is supplied by either unit ventilator (univent) systems or supply vents ducted to rooftop air-handling units (AHUs).

Approximately half of the classrooms surveyed had univents (Picture 1). A univent draws air from outdoors through a fresh air intake located on the exterior wall of the building (Picture 2) and returns air through an air intake located at the base of the unit (Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through a diffuser located on the top of the unit. Adjustable louvers control the ratio of fresh and recirculated air. These univents are equipped with mesh filters that were last changed during winter break (Picture 3). Obstructions to airflow, such as furniture located in front of and/or materials stored on univents, were observed in some areas. Some univents were also deactivated at the time of assessment. In order for univents to provide fresh air as designed, these units must be activated and remain free of obstructions.

Mechanical exhaust ventilation for these areas is provided by ceiling- or wall-mounted vents connected to rooftop fans (Pictures 4 and 5). This system was operating, although weakly in some areas, during the assessment. It is important to note that the location of some exhaust vents can limit exhaust efficiency. In some classrooms, ceiling-mounted exhaust vents are located above hallway doors (Picture 4). When classroom doors are open, exhaust vents will tend to draw air from both the hallway and the classroom. The open hallway door reduces the effectiveness of the exhaust vent to remove common environmental pollutants from classrooms. In some instances, wall-mounted exhaust vents were obstructed by furniture (e.g., book cases, file cabinets). Such obstructions also reduce the capability of the exhaust system to remove common classroom pollutants.

For the remainder of school areas, ventilation is provided by rooftop air handling units (AHUs). Fresh tempered air is supplied through ceiling mounted air diffusers (Picture 6) and ducted back to the AHUs via return vents (Picture 7). These AHUs have localized thermostats that allow a computer system to monitor and control the AHUs. At the time of the assessment, supply of air via the ceiling vents could not be detected. This may indicate that either the AHUs were off or that the units were set to ‘automatic’. When an AHU’s setting is programmed to automatic, the HVAC system’s thermostat is set at a preset temperature. Once the thermostat registers the preset temperature, the computer system deactivates the HVAC system. No mechanical ventilation is provided until the thermostat calls for the computer to re-activate the system. In addition, some return vents for these areas are located near hallway doors; as discussed, such location can prevent effective removal of classroom pollutants.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate *continuously* during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room, while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The HVAC system was likely balanced prior to occupation in 1993.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see Appendix A.

Temperature measurements ranged from 67^{o} F to 79^{o} F in areas throughout the school and 81 ^{o} F in the pool room. Temperature measurements for most areas were within the MDPH recommended comfort range on the day of the assessment. The MDPH recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. Many occupants had concerns of uneven heating, particularly with classrooms being too warm. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 22 to 37 percent in areas throughout the school and 50 percent in the pool room. Relative humidity measurements for classrooms, offices and other typical indoor school settings were below the range of the MDPH recommended comfort on the day of the assessment. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Of note are relative humidity measurements in the hallway outside the pool, which ranged from 32 percent to 40 percent; these measurements exceeded outdoor measurements by 11 to 19 percent on the day of the assessment. These measurements, as well as the odor of chlorine detected in hallways and classrooms, indicate that both air and moisture are penetrating into adjacent areas of the school from the pool area. The increase in relative humidity can indicate that the pool exhaust system is not operating sufficiently to remove water vapor and chlorine odor. Rooftop AHUs and exhausts should be examined to ensure proper function. Ventilation equipment for the pool area should also be examined to ensure pool exhaust is not being entrained into the general HVAC system (i.e., AHUs and univents).

Microbial/Moisture Concerns

A few hallway areas had water-stained ceiling tiles (Picture 8), most likely from a roof or pipe leak. Water-damaged ceiling tiles can provide a source for mold and should be replaced after a water leak is discovered and repaired. Ceiling tiles in some areas had been removed after water damage occurred; replacement tiles were reportedly on order at the time of the assessment.

Open seams between the sink countertop and backsplash were observed in several rooms (Picture 9). If not watertight, water can penetrate through the seam, causing water damage. Water penetration and chronic moisture exposure of porous and wood-based materials may lead to subsequent mold growth.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Plants were noted in several areas, with some placed on top of univents or near ventilation sources (Picture 10). Plants, soil and drip pans can serve as sources of mold growth and thus should be properly maintained. Plants should have drip pans to prevent wetting and potential mold growth on the surface of which it is placed. Drip pans should also be cleaned and maintained to prevent potential mold growth (Picture 11). Plants should also be located away from univents and ventilation sources to prevent aerosolization of dirt, pollen or mold.

Several classrooms contained aquariums and terrariums (Picture 12). Aquariums should be properly maintained to prevent microbial/algae growth and unpleasant odors. Similarly, terrariums should be properly maintained to ensure soil does not become a source for mold growth and/or odors.

Several potential pathways for moisture to enter the building were identified, most notably around window frames, where rubber gaskets were damaged or loose (Picture 13). Gaskets should be repaired or replaced to prevent water intrusion to the building.

Evidence of efflorescence on the building exterior was observed (Picture 14). Efflorescence is a characteristic sign of water damage to brick and mortar, but it is not mold growth. As moisture penetrates and works its way through mortar and brick, water-soluble compounds in mortar and brick dissolve, creating a solution. As the solution moves to the surface of the mortar or brick, the water evaporates, leaving behind white, powdery mineral deposits. Over time, mortar can become damaged or missing, allowing water to penetrate the building. Since the building is of brick, concrete and metal construction, the building is also prone to condensation generation due to temperature differences between metal beams and materials in contact with the beams (Picture 15). As a result, cement and brick and mortar may be experiencing chronic moistening. As discussed, chronic moisture can result in damage to the building envelope and subsequent water penetration. Consideration should be given to examining the building exterior and, where necessary, repoint mortar and repair concrete.

Other IAQ Evaluations

Indoor air quality can be adversely impacted by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion products include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, CEH staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide pollution and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were 4 ppm. Carbon monoxide levels measured in the school ranged between 2 and 3 ppm (Table 1). The school is located near a moderate to heavily frequented road, resulting in increased carbon monoxide levels in the outdoor environment, which can subsequently be drawn indoors.

As previously mentioned, the US EPA also established NAAQS for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2000a). This standard was adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM2.5 standard requires outdoor air particulate levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, CEH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 12 $\mu g/m^3$. PM2.5 levels measured indoors ranged from 2 to 17 $\mu g/m^3$ (Table 1), which were below the NAAQS of 65 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be impacted by the presence of materials containing volatile organic compounds (VOCs). VOCs are substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Outdoor air samples were taken for comparison. Outdoor TVOC concentrations were ND. Indoor TVOC measurements throughout the building were also ND (Table 1).

Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC-containing products. While no measurable TVOC levels were detected in the indoor environment, VOC-containing materials were noted. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Cleaning products were found on countertops and beneath sinks in a number of classrooms. Cleaning products contain VOCs and other chemicals, which can be irritating to the eyes, nose and throat and should be stored properly and kept out of reach of students.

Duplication machines are located in a number of areas. Photocopiers can produce VOCs and ozone, particularly if the equipment is older and in frequent use. VOCs and ozone are respiratory irritants (Schmidt Etkin, 1992). Of note is that at least one machine, the Risograph®, uses a liquid toner. Dedicated local exhaust ventilation was observed operating above all duplicating machines (Picture 16). Faculty and staff should ensure that local exhaust ventilation is operating when using equipment to ensure pollutants are being removed. Without operating exhaust ventilation, pollutants generated by duplicating equipment would accumulate in the occupant areas as duplication equipment is operating.

In an effort to reduce noise from sliding chairs, tennis balls had been spliced open and placed on chair legs (Picture 17). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and off gas VOCs. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix B (NIOSH, 1998). School officials indicated that replacements similar to those depicted in Picture 18 were on order.

Accumulated chalk dust was seen in chalk trays of some classrooms. Chalk dust is a fine particulate that can easily become aerosolized, irritating eyes and the respiratory system. Consideration should be given to increasing frequency of chalk tray cleanings to prevent accumulation.

In several classrooms, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. Dust can be irritating to eyes, nose and respiratory tract.

A number of exhaust/return vents, univent supply vents and personal fans had accumulated dust (Pictures 19 and 20). If exhaust vents are not functioning, back drafting can occur, which can re-aerosolize accumulated dust particles. Re-activated univents and fans can also aerosolize dust accumulated on vents/fan blades. It appears that a univent in the art area is being used to dry clay, papier-mâché and other art projects (Picture 21). Dust, particles and other materials from these projects can collect in the univent and be distributed. In addition, clays contain silicates which can become easily aerosolized and serve as eye and respiratory irritants. The Center for Occupation Hazards, located in New York City, recommends avoiding all procedures that create dust (COH, 1979). Several measures to avoid the accumulation of clay particles and other respirable dusts include wet mopping and wet wiping of horizontal surfaces (sweeping and dusting can stir up fine particulates) and use of a vacuum cleaner equipped with a high efficiency particulate arrestance (HEPA) filter to reduce the aerosolization of dust.

Air purifiers equipped with HEPA filters were observed in some areas (Picture 22). Air filters for this type of equipment should be cleaned or changed as per the manufacturer's instructions to avoid reaerosolization of dusts and particulates. Air purifiers should also be placed within the breathing zone, rather than on the floor.

A helper dog was observed in one classroom. The dog appeared to be resting on a pillow or similar upholstered furniture. Porous materials (i.e., upholstered furniture) can be a reservoir for collecting animal dander, fur and wastes, which can all be sources of respiratory irritants. Upholstered items should be cleaned regularly to avoid the aerosolization of allergenic materials and/or odors. In order to remove dust mites and other pollutants, frequent vacuuming of upholstered furniture is recommended (Berry, 1994). It is also recommended that upholstered furniture present in schools be professionally cleaned on an annual basis or every six months if dusty conditions exist (IICRC, 2000).

As previously discussed, pool odors (i.e., chlorine odors) were reported in a number of areas throughout the school. Odors are reportedly most notable in classroom 217, which is located on the second floor, adjacent to the indoor pool wing and stairwell (Picture 23). Pool odors are reportedly strongest on Monday mornings. This classroom has a univent system that, as with all HVAC equipment in the building, is turned off or operated at the minimum level over the weekends as a measure to conserve energy. As previously discussed, without operating ventilation equipment, indoor pollutants cannot be removed or diluted. Consideration should be given to operating ventilation equipment in this area, even during non-school hours. HVAC equipment to the pool should also be examined to ensure continuous operation at all times.

Given the proximity and location of the areas experiencing problems with pool odors (i.e., neighboring areas in a corner of the building), it is especially important that positive pressurization within these areas be maintained via continuous operation of HVAC equipment. The corner in which the fresh air intake for classroom 219 is located is at a junction at which odors and materials can become trapped. Maintaining positive pressure in the building would help reduce infiltration of pool odors to these areas.

The presence of pool related odors in occupant areas indicates that breaches (i.e. utility holes, cracks) exist, allowing movement of odors to areas surrounding the pool. The pool room, adjacent hallway and stairwell should be examined for odor pathways and be sealed and/or stopped to prevent movement and penetration of odors to adjacent areas. For example, door sweeps should be placed on the doors leading to the pool area to prevent movement of odors into the hallway and stairwell (Picture 24). At the time of the assessment, doors in the hallway leading to the pool room were propped open; these doors should remain closed to prevent the migration of odors into hallways.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made to improve general indoor air quality:

1. Operate both supply and exhaust ventilation *continuously* during periods of school occupancy. Ensure all HVAC equipment and related equipment (i.e., thermostats) are set to 'on' or 'continuous'.
2. Remove all blockages from univents and exhaust vents.
3. Ensure hallway doors are closed to maximize air exchange.
4. Ensure ventilation equipment is operating in the pool area to prevent build up of odors.
5. Consider having the ventilation system balanced by an HVAC engineer every five years (SMACNA, 1994).
6. Consider operating ventilation equipment in areas adjacent to the pool area continuously, even during non-school hours, to prevent pool odor buildup.
7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted

to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

8. Ensure roof and/or plumbing leaks are repaired, and replace any water-stained/missing ceiling tiles. Examine the space above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
9. Move plants away from univents in classrooms. Ensure all plants are equipped with drip pans. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.
10. Clean and maintain aquariums and terrariums to prevent mold growth and associated odors.
11. Contact a masonry firm or general contractor to examine the building exterior to determine integrity of mortar.
12. Repair/replace failing rubber gaskets in windows.
13. Continue with plans to replace tennis balls on chair legs with alternative glides.
14. Store cleaning products properly and out of reach of students.
15. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

16. Install door sweeps to doors leading to/from the pool area. Ensure these doors are closed to prevent movement of odors.
17. Clean upholstered furniture to prevent buildup of irritants. Consider vacuuming with a HEPA filter equipped vacuum and wet washing/wiping to reduce dust, dander, and allergens/asthmagens.
18. Consider adopting the US EPA (2000b) document, "Tools for Schools", to maintain a good indoor air quality environment in the building. This document can be downloaded from the Internet at http://www.epa.gov/iaq/schools/index.html.
19. Refer to resource manuals and other related indoor air quality documents for additional building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website: http://mass.gov/dph/indoor_air.

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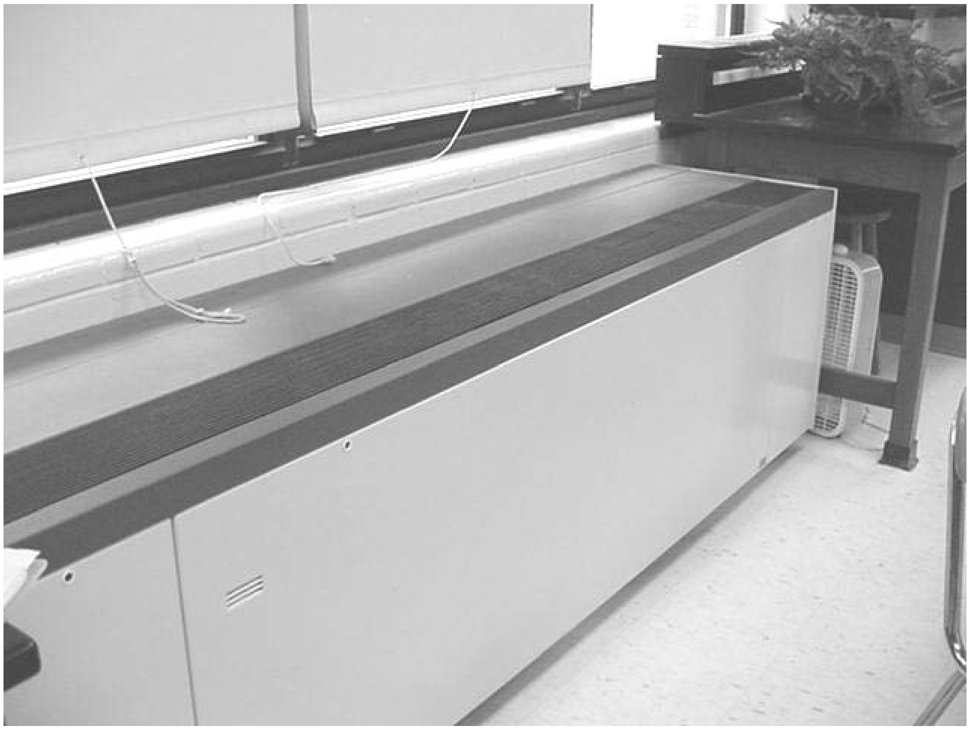
Picture 1



Classroom Univent

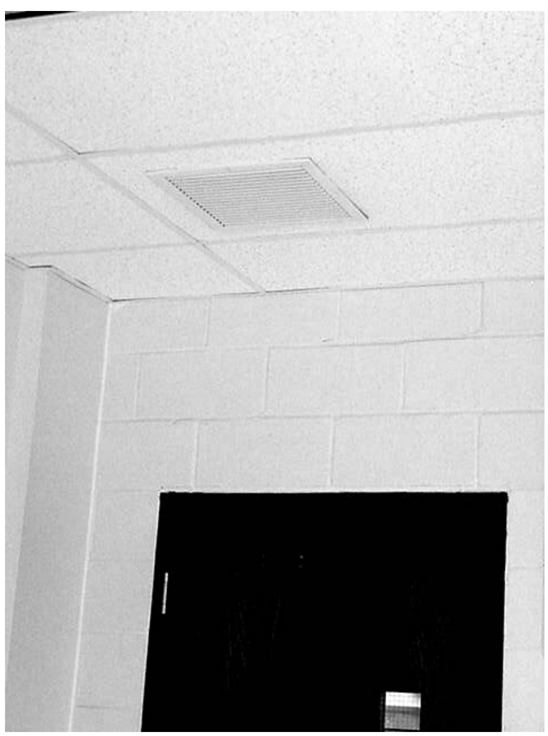
Picture 2

Univent fresh air intake

Picture 3

Mesh univent filters with replacement date

Picture 4



Exhaust vent located near door to hallway

Picture 5

Wall exhaust partially obstructed by file cabinet

Picture 6

Ceiling supply vent

Picture 7

Ceiling-mounted return vent

Picture 8

Missing and water damaged ceiling tiles in hallway

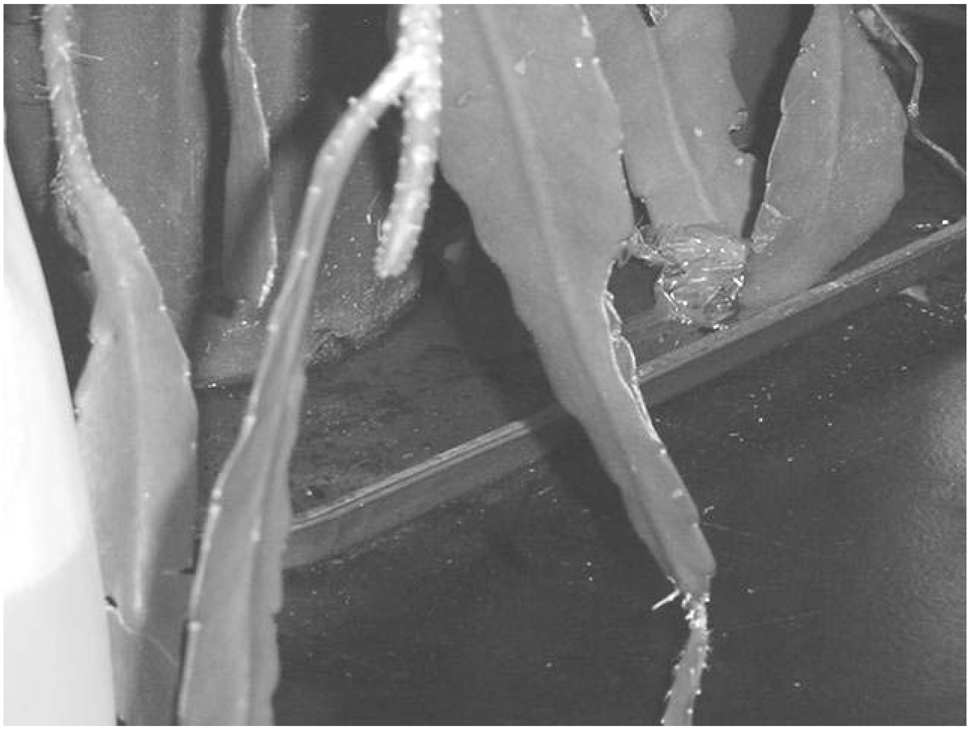
Picture 9

Breach between sink countertop and backsplash

Picture 10

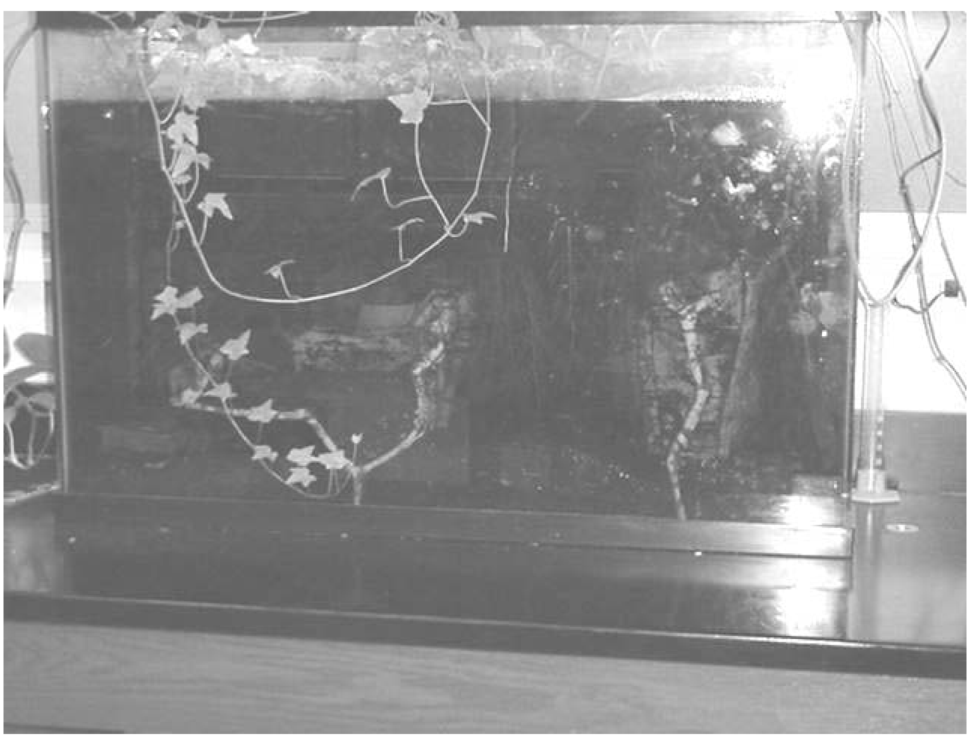
Plants on univent

Picture 11



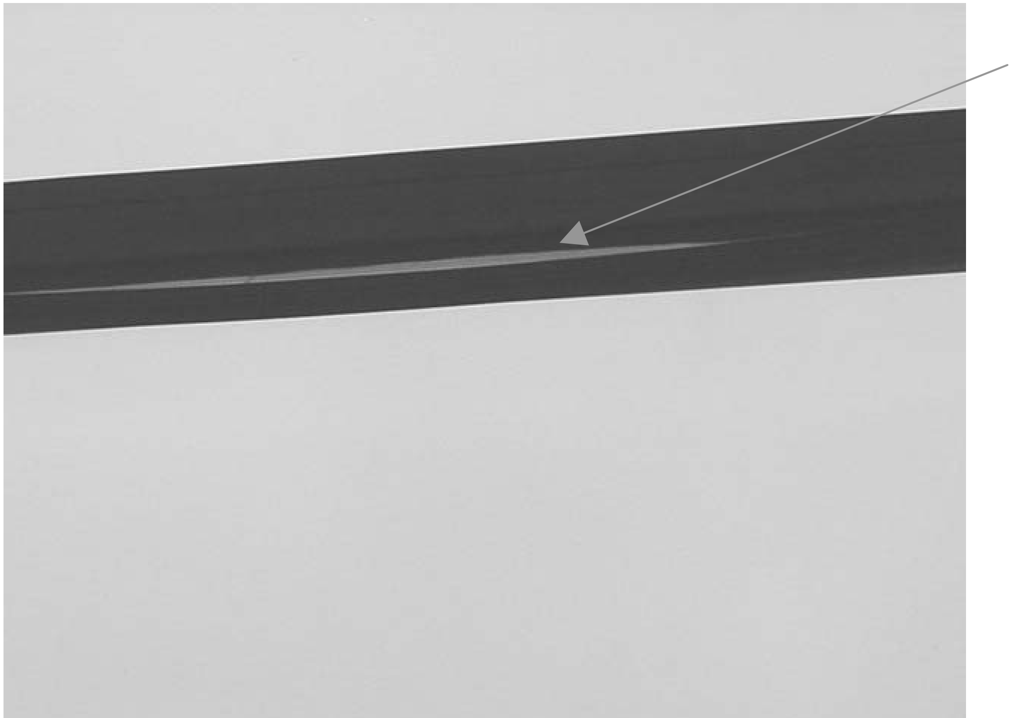
Plant drip pan, note debris and rust

Picture 12



Aquarium, note turbidity of water

Picture 13



Space between rubber gasket and window frame

Picture 14

Efflorescence on building exterior

Picture 15

**Brick, cement and metal construction,
Note wet spots on cement slabs below metal window frames**

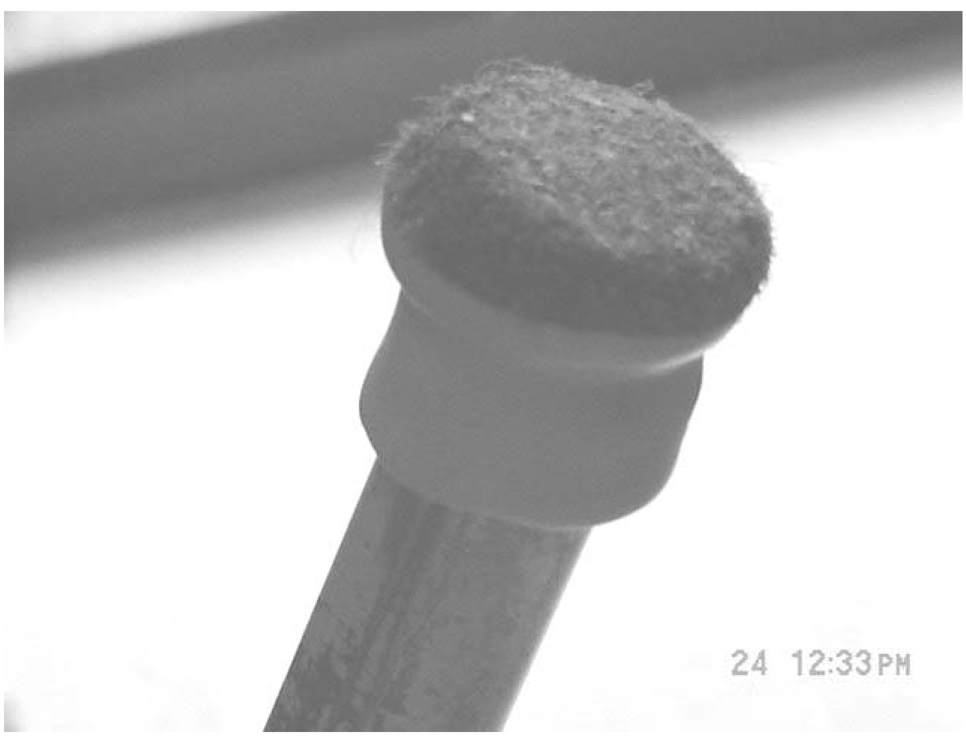
Picture 16

Dedicated exhaust for photocopier

Picture 17

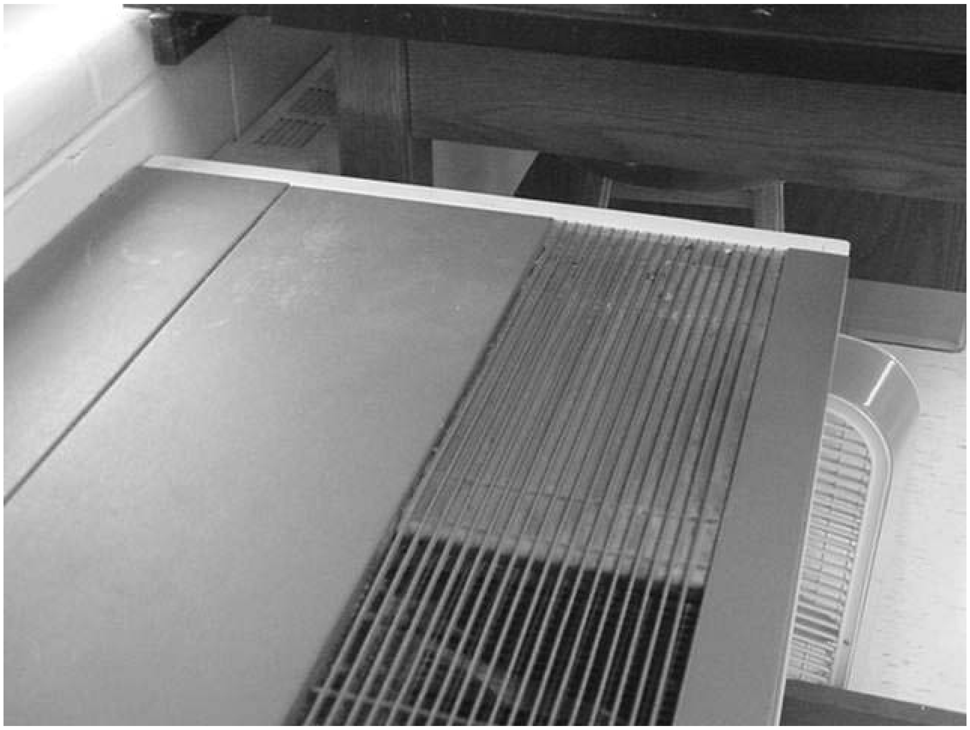
Tennis balls on chair legs

Picture 18



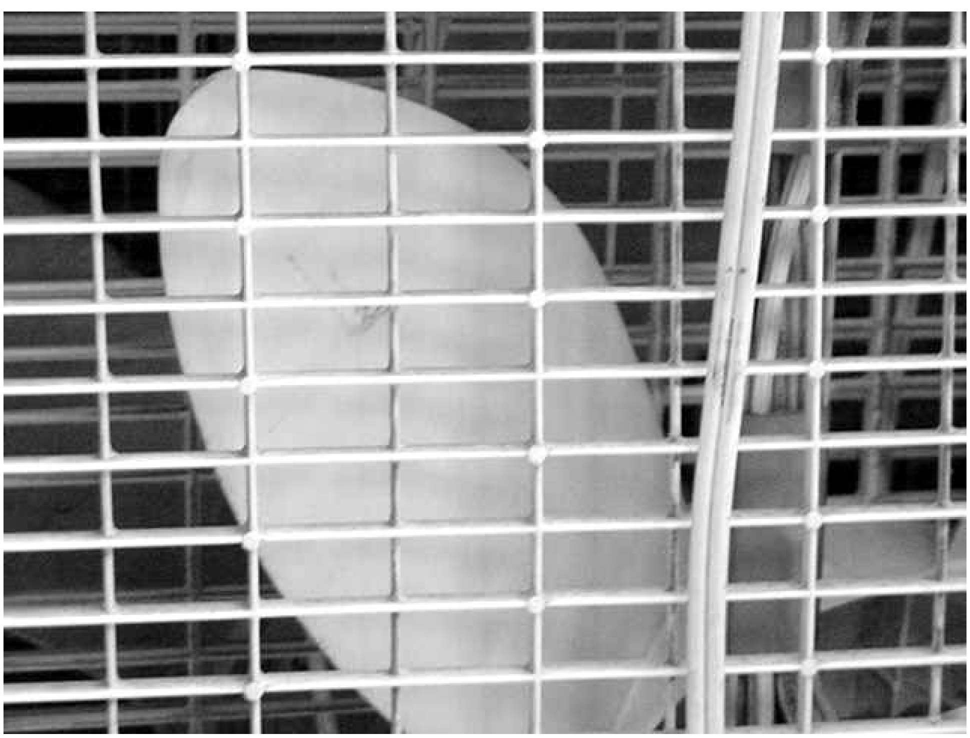
Alternative "Glides" for Chair Legs

Picture 19



Accumulated dust in univent fresh air diffuser

Picture 20



Dust accumulation on fan blades

Picture 21

Items on univent, note materials adhered to diffuser

Picture 22

Air purifier with HEPA filter

Picture 23

Location of classroom 219 in relation to pool,
Note fresh air intake for classroom 219 is located behind peak of foyer roof

Picture 24

Door between pool room and foyer, note spaces around door

John F. Kennedy Middle School
100 Bridge Road, Florence, MA 01062

Indoor Air Results
Date: 1/6/2006

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
background	0	35	21	478	4	ND	12	N			
cafeteria	30	71	28	876	2	ND	7	N	Y wall	Y wall	Hallway DO,
computer lab	11	77	27	977	2	ND	3	N	Y ceiling	Y ceiling	Hallway DO, local AC, 28 computers.
computer lab 2	11	74	27	1207	2	ND	11	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, DEM.
exam a	0	69	28	866	3	ND	4	Y # open: 0 # total: 1	Y ceiling (off)	Y ceiling	Hallway DO,
exam b	0	70	28	904	3	ND	5	Y # open: 0 # total: 2	Y ceiling (off)	Y ceiling	Inter-room DO,
guidance	0	69	29	898	3	ND	2	N	Y ceiling (off)		Hallway DO,

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Temperature: 70 - 78 °F
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John F. Kennedy Middle School
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									Supply	Exhaust	
guidance library	1	73	26	915	3	ND	2	N	Y ceiling (off)	Y ceiling	Hallway DO, copier, AP, wet toner copier/Risograph.
gym	13	71	35	746	3	ND	13	N	Y ceiling	Y wall (off)	pool odors.
library	12	72	25	895	3	ND	10	Y # open: 0 # total: 12	Y ceiling	Y ceiling	Hallway DO, laminator, plants.
nurse's office	2	69	30	948	3	ND	4	N	Y ceiling (off)	Y ceiling	Inter-room DO,
pool	6	81	50	615	3	ND	5	N	Y ceiling	Y wall	pool hallway: 32-40 percent RH.
rehearsal room	0	69	27	977	2	ND	6	Y # open: 0 # total: 4	Y ceiling	Y ceiling location	Hallway DO, CD.
staff/copy room	0	77	25	1179	3	ND	6	Y # open: 0 # total: 3	Y ceiling (off)	Y ceiling	Inter-room DO, copier, PC.

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									Supply	Exhaust	
101 (French)	1	67	37	1637	2	ND	9	Y # open: 0 # total: 0	Y ceiling (off)	Y ceiling location	CD, TB, temperature complaints (hot).
102	2	68	32	1060	3	ND	7	N	Y ceiling (off)	Y ceiling location	CD.
103	0	72	25	982	3	ND	6	Y # open: 0 # total: 1	Y univent	Y ceiling	Hallway DO, CD, PF.
104	3	75	23	937	3	ND	7	N	Y univent furniture	Y ceiling	CD, PF.
107 (community room)	0	72	26	880	2	ND	3	N	Y ceiling	Y ceiling	CD.
108 (visual arts)	13	78	27	1035	2	ND	13	N	Y univent (weak)	Y wall location	FC re-use, items.
109	9	72	27	1228	3	ND	8	N	Y univent items	Y ceiling	cleaners.

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									Supply	Exhaust	
110 (tech/shop)	13	71	28	1251	3	ND	6	N	Y univent	Y wall	#MT/AT: 1.
112	10	71	31	910	2	ND	16	Y # open: 0 # total: 7	Y univent dust/debris	Y ceiling	
113	4	71	27	954	3	ND	5	N	Y univent	Y ceiling	cleaners.
114	9	70	29	976	3	ND	8	Y # open: 0 # total: 8	Y univent	Y wall	breach sink/counter, plants.
115	0	71	32	793	3	ND	6	N	Y univent furniture	Y ceiling	CD, pool odors.
116	9	74	27	991	2	ND	9	N	Y ceiling	Y ceiling location	breach sink/counter.
118	1	72	23	799	3	ND	8	Y # open: 0 # total: 9	Y univent	Y wall furniture	Hallway DO, FC re-use.

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119	1	74	24	797	2	ND	8	N	Y univent	Y wall furniture	Hallway DO, damaged/missing window caulking/gasket, TB.
120	17	75	27	1330	3	ND	9	Y # open: 0 # total: 8	Y univent furniture	Y wall	Hallway DO, plants.
121	16	73	27	1147	3	ND	10	Y # open: 0 # total: 7	Y univent items	Y wall furniture	breach sink/counter.
122	8	77	28	1170	2	ND	9	N	Y univent	Y wall furniture	CD, PF.
123 (music)	10	68	29	973	2	ND	8	Y # open: 0 # total: 4	Y ceiling items	Y ceiling location	Hallway DO, CD.
124 (music)	10	68	26	916	3	ND	9	Y # open: 0 # total: 3	Y univent furniture	Y ceiling	Hallway DO, breach sink/counter.
125	14	73	28	1228	3	ND	7	Y # open: 0 # total: 8	Y univent items	Y wall furniture	

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									Supply	Exhaust	
126	20	73	28	1135	3	ND	17	Y # open: 0 # total: 9	Y univent	Y wall	Hallway DO, breach sink/counter, CD, PF, UV cover off, screw inserts on order.
127	0	73	25	814	3	ND	9	Y # open: 0 # total: 8	Y univent (off)	Y wall furniture	Hallway DO, breach sink/counter, CD, PF, items, plants.
128	12	73	30	1359	3	ND	11	Y # open: 0 # total: 8	Y univent	Y wall	Hallway DO, breach sink/counter, PF, cleaners, items, plants.
129	1	73	27	1775	3	ND	8	N	Y univent dust/debris	Y wall	CD, TB, cleaners.
144	5	71	28	1073	3	ND	6	N	Y ceiling	N	
201	13	75	29	1298	3	ND	10	Y # open: 0 # total: 2	Y ceiling (off)	Y ceiling	CD, TB.

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									Supply	Exhaust	
202	20	76	28	1489	3	ND	7	Y # open: 0 # total: 2	Y ceiling (off)	Y ceiling location	CD, PF, TB, items.
203	26	75	26	1160	3	ND	6	Y # open: 0 # total: 4	Y ceiling (off)	Y ceiling location	CD.
204	13	73	27	1234	3	ND	9	Y # open: 0 # total: 4	Y univent	Y ceiling location	CD, plants.
205	5	75	24	961	3	ND	5	Y # open: 0 # total: 3	Y ceiling (off)	Y ceiling location	CD, PF.
206	0	74	25	875	3	ND	10	Y # open: 0 # total: 3	Y ceiling (off)	Y ceiling location	
208	25	75	27	1116	3	ND	8	Y # open: 0 # total: 4	Y ceiling (off)	Y ceiling location	items.
209	22	73	27	1240	3	ND	10	Y # open: 0 # total: 4	Y univent	Y ceiling	plants.

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210	14	75	26	1015	3	ND	6	Y # open: 0 # total: 10	Y ceiling (off)	Y ceiling	PF.
211	1	74	25	1087	3	ND	11	Y # open: 1 # total: 4	Y univent	Y ceiling	Hallway DO, PF, dust, items, pets, plants, dust complaints; helper dog.
212	20	73	24	1122	3	ND	7	Y # open: 2 # total: 5	Y univent	Y ceiling location	PF, temperature complaints (hot), windows typically open to alleviate heat.
213	19	72	30	1968	3	ND	9	Y # open: 0 # total: 6	Y univent	Y wall	CD, PF.
214	23	73	28	1485	3	ND	12	Y # open: 0 # total: 5	Y univent	Y ceiling location	Hallway DO,
215	10	72	23	949	3	ND	6	Y # open: 0 # total: 2	Y univent	Y ceiling location	Hallway DO,
216	18	73	29	1618	3	ND	8	Y # open: 0 # total: 8	Y univent	Y wall	CD, PF, items.

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217	4	73	28	1254	3	ND	11	Y # open: 0 # total: 4	Y univent	Y wall	Hallway DO, CD, TB, pool chlorine odors.
218	16	74	26	1350	3	ND	7	Y # open: 0 # total: 3	Y univent	Y ceiling	items.
219	28	72	28	1469	3	ND	12	Y # open: 0 # total: 8	Y univent dust/debris	Y wall (off)	Hallway DO, CD.
221	11	73	24	870	3	ND	13	Y # open: 0 # total: 8	Y univent	Y (off) furniture	Hallway DO, dust.
222	26	69	24	981	3	ND	9	Y # open: 0 # total: 4	Y univent	Y ceiling	CD.
223	13	73	23	1078	3	ND	7	Y # open: 0 # total: 8	Y univent	Y ceiling	Hallway DO, CD, PF, items.
224	23	75	24	1275	3	ND	10	Y # open: 0 # total: 6	Y univent	Y ceiling	Hallway DO, CD, DEM, PF.

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225	1	74	27	1027	3	ND	4	Y # open: 0 # total: 5	Y ceiling	Y ceiling	
226	0	75	25	1061	3	ND	4	Y # open: 0 # total: 4	Y ceiling	Y ceiling	Hallway DO, CD, PF.
227	1	78	22	1050	3	ND	6	Y # open: 1 # total: 3	Y univent (off)	Y ceiling	Hallway DO, CD, DEM, TB.
228	1	79	24	1532	3	ND	9	Y # open: 0 # total: 3	Y ceiling	Y ceiling (off)	Hallway DO, Inter-room DO, plants.
229	6	78	25	1166	3	ND	13	N	Y ceiling	Y ceiling location	Hallway DO, CD, items.

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